JURASSIC PERIOD—*continued.*

LIASIEN, D'Orb. Marlstone (Phil.) *Upper bed*—Blackish compact limestone Inc. from 75 to 90 deg. N.; 100 metres thick; poor in fossils. *Amm. lunula*, Zeit. Loc. Mount Monnier, Fontan.

Lower bed—Metamorphic limestone, black marble, with white sparry veins, Coprolites. Loc. Chaudan, Mount Monnier.

SINÉMURIEN, D'Orb. Lower Lias Shale (Phil.) *Upper bed*—Lead grey coloured limestone, breaking up by exposure to the atmosphere. Inc. 80 to 90 deg. N.; 30 metres thick; poor in fossils. *Ostrea arcuata*, Brong. Loc. Mount Vanque, Mount Monnier.

V. TRIASSIC PERIOD.

SALIFERIEN, D'Orb. Red Marl (Murchison). *Upper bed*—Salt Springs and Saline Alluviums. Loc. Amen, Sausse, Roquette, Tignet.

CONCHYLIEN, Brong. New Red Sandstone (Murch.). *Upper bed*—Compact Limestone, breaking up by exposure to atmosphere. Loc. Mandelieu, Pégomas, Iles Lérins.

VI. PALÆOZOIC PERIOD.

PERMIEN, Murch. and Vern. Lower Red Sandstone. *Upper bed*—Violet coloured fine Sandstone of the Vosges, etc. Petrosiliceous rock, without fossils. Loc. Belvedere, Val de Spaillars.

CARBONIFERIEN, D'Orb. Carboniferous Limestone. *Upper bed*—Red tinted compact Limestone in amorphous masses. Loc. Summit of Mount Bégo.

— *Middle bed*—Red and gray slaty schists with iron. Loc. Boquebilliere Fontan.

— *Lower bed*—Limestone with quartzose conglomerate, etc. Loc. Foot of Mount Bégo.

DEVONIEN, Murch. Old Red Sandstone (Murch.). *Upper bed*—Fetid grey limestone or greywacke. Loc. Mount Raus, Saorge Breil.

SILURIAN. Upper Silurian (Murch.). Black friable Marly Schists. Loc. Col. Formosa, foot of Mount Abyme.

VII. PERIODE AZOIQUE STRATIFIÉE, D'Orb.

TALCITES, D'Orb. Talc plastique. *Upper bed*—Aluminous Talc, etc. No fossils. Loc. Col. de la Querce, baisse de St. Véran.

— *Lower bed*—Calcareous Talc, siliceous, compact, antimonius (serpentines, chloromélanite). Loc. Vallauris, Biot, St. Anne, Riofredo.

MICACITES, D'Orb. Mica schists, Syenites in large masses, in thin layers or schistose. Mica, black felspar with siliceous paste. Loc. Col long, St. Anne, Cannes.

GNEISS, Brêchiole, red porphyry. *Upper bed*—Compact red porphyry: crystalline rocks. Loc. Croisette, Cannes, Esterel.

— *Middle bed*—Coarse Gneiss, or Gneiss with large grains, crumbling by exposure to the atmosphere; white quartz. Black felspar. Loc. Mount Malcontourn.

— *Lower bed*—Fine Gneiss; or Gneiss with fine grains, white or with black spots. Loc. Salése, Trinité, Borréon.

AZOIC PERIOD. Rocks not stratified. White snow-coloured Granite, with fine grains, spotted by small dots of black felspar. Alpine type. Loc. Mount Gelas, St. Martin Lantosque.

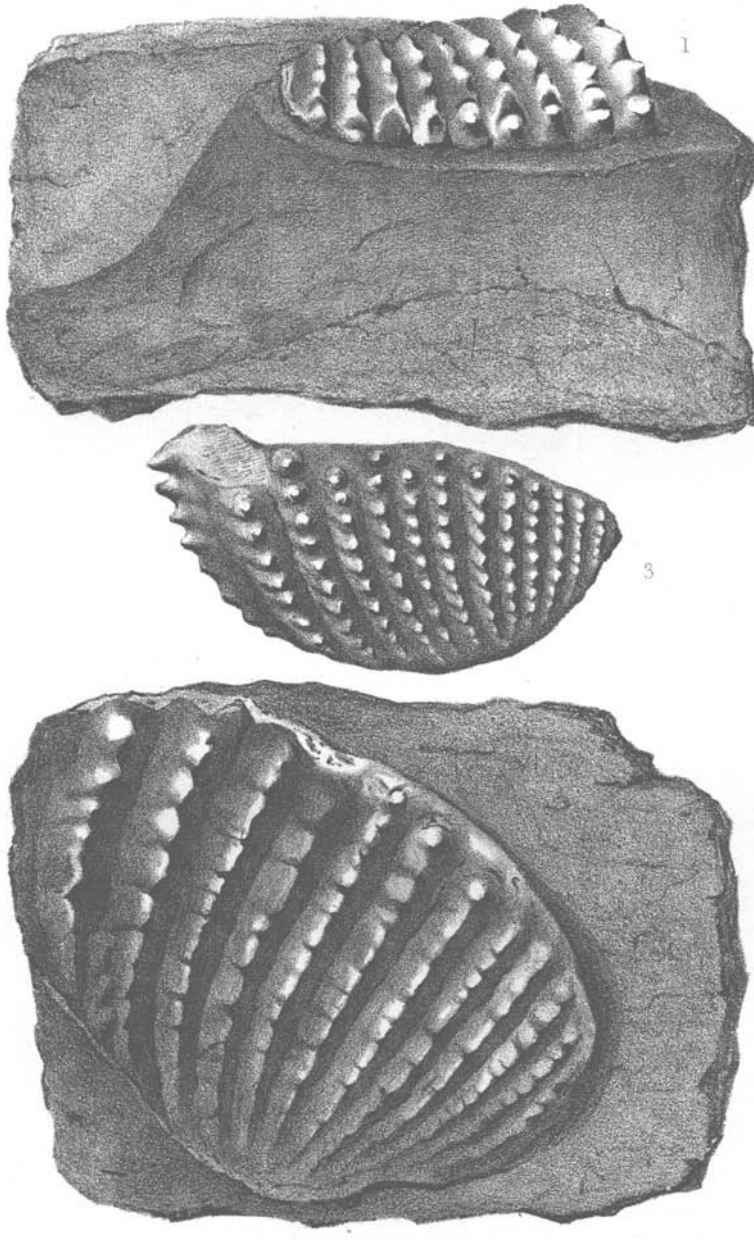
(*To be continued*).

III.—NOTES ON VARIOUS SPECIES OF *CTENODUS* FOUND IN THE LOW MAIN COAL-SHALE, NEWSHAM COLLIERY, NORTHUMBERLAND.

By T. P. BARKAS, F.G.S.

(PLATE IX., Figs. 1 and 2).

FOR many years the various Coal-shales and other strata associated with the Coal-seams of Northumberland have been known to be rich in the remains of Plants, and the majority of the specimens which are illustrated in Lindley and Hutton's elaborate



R. DeWilde del et lith. W. West imp.

Mandibular and
Palatal Teeth of Ctenodus.
Natural Size.
Coal Measures.

work on the Flora of the Coal-period were obtained from collieries in Northumberland and the adjoining county, Durham. It is only within the last few years that close attention has been directed to the investigation of the fauna of the Northumberland coal-fields. The first systematic investigator of the fauna of the Carboniferous period in this locality was Mr. Thomas Atthey, late of Cramlington, now of Gosforth; and within the last few years Messrs. Kirby, Sim, Taylor, and Craggs have each secured good collections of the Carboniferous fossils.

Among the most numerous animal-remains discovered in the Northumberland Coal-measures are those of various species of fishes of the genus *Ctenodus*, of which as yet little is positively known, further than that their oral armature was of a very peculiar description, and that their opercular plates and head-bones to a great extent resemble those of *Dipterus*, as described by Hugh Miller.[1] As the species to which I am about to refer have been previously described in the "Annals of Natural History" by Messrs. Hancock and Atthey, but have not been figured, I desire to direct the attention of the readers of the GEOLOGICAL MAGAZINE to figures of the largest and most rare of the species obtained in our Northern coal-fields.

In the articles just referred to there are seven species described, six of which are new and one, *Ctenodus cristatus*, which is at present in the Leeds Museum, was described and figured by Prof. Agassiz in his "Poissons Fossiles," vol. iii. p. 137, pl. 19, fig. 16. Prof. Agassiz figures four additional species in his "Monogram des Poissons Fossiles du Vieux Grès-rouge," none of which correspond with those referred to, which have by Messrs. Hancock and Atthey been named *Ctenodus tuberculatus, C. corrugatus, C. obliquus, C. elegans, C. imbricatus*, and *C. ellipticus*.

Ctenodus cristatus is very rare in our coal-shale; I have only succeeded in obtaining one specimen, but that fortunately has associated with it a perfect sphenoid bone, a beautiful opercular plate, and several of the head bones of the fish. At the edge of the slab containing the specimen there are impressions of three tubercles, which have been made by the tubercular prominences of another tooth, but unfortunately the specimen which left the impressions has not been obtained. The tooth now in my possession is two inches long, $1\frac{1}{4}$ inch broad, has twelve ridges strongly marked with sharp-pointed denticles, and bears a considerable resemblance to the specimen in Agassiz "Poissons Fossiles." The opercular plate is thick and strong, and is rather deeply marked with vermicular reticulating lines, somewhat resembling those which cover the maxillary bones of *Rhizodopsis*, and which underlie the polished covering of the scales and bones of *Megalichthys*; it is $1\frac{3}{4}$ inch long, and $1\frac{3}{8}$ inch broad. I have in my possession a large, nearly circular, opercular plate, which is supposed to belong to one of the *Ctenodi*; it is $6\frac{1}{4}$ inches in its longer diameter and 6 inches in its narrower, and is about $\frac{3}{8}$ of an inch thick at its thickest part. To what species this large operculum belongs I do not know; but assuming that it bears the same pro-

[1] "Footprints of the Creator," p. 58, new issue.

portion to the size of the fish that the opercular plate of *C. cristatus* does to the fish to which it belonged, it must have been, according to the estimation of competent palæontologists, little short of ten feet in length. I have not yet discovered any palate teeth of a size proportioned to opercular plates so large as that just described; the largest tooth I have obtained, and, I have reason to believe, the largest that has been obtained anywhere, is a palatal tooth, which, provisionally, I ascribe to *Ctenodus tuberculatus*, although it in some respects differs materially from the description of that species given in the "Annals of Natural History."

In order to afford an opportunity of estimating the appearance and size of teeth of this species, figures are annexed (see Plate IX.) of a palatal (Fig. 2) and mandibular tooth (Fig 1).

Fig. 2 represents a palatal tooth, and Fig. 1 a mandibular tooth (both of the natural size) with the mandible attached and *in situ*. The figures represent teeth belonging to the same species, and although they were not obtained on the same day, it is not improbable that both belonged to the same fish—their sizes, state of preservation and general appearance so closely resemble each other. Of the teeth of *C. tuberculatus* I have but three specimens, those figured and a fragment of a mandibular tooth which has eight perfect ridges, one of which I have removed for the purpose of making a section for microscopic examination. The bony texture of the tooth is exceedingly hard, the base being very open and cellular; but the exterior grinding portion being dense, thick and hard, it must have offered a formidable surface for crushing food during the lifetime of the fish. This excessive hardness of the outer enamel will account for the fact that the greater proportion of the palatal and mandibular teeth that have been found are as perfect, sharp, and well-defined as though they had never been used. The cellular portions of the teeth and plates of attachment of the *Ctenodi* bear considerable resemblance to the *Pleurodi* and *Pœcilodi* in their microscopic structure.

Of *Ctenodus corrugatus* I have not found a single specimen; the only remains of that species with which I am acquainted being a palatal tooth, which is preserved in the Museum of the Natural History Society of Newcastle-on-Tyne. The tooth is crossed by nine irregular, corrugated ridges, and is remarkably unlike the teeth of any other known species of *Ctenodi*. I have obtained about two hundred specimens of *C. elegans*, *C. obliquus*, *C. imbricatus*, and *C. ellipticus*, several of which have been presented to museums and private palæontologists. In my collection there are also three specimens with four ridges, probably new to science, and many specimens respecting which I have not yet obtained any satisfactory information.

EXPLANATION OF PLATE IX.—Figs. 1 and 2.

Fig. 1.—Mandibular tooth of *Ctenodus tuberculatus*.
„ 2.—Palatal tooth of same,
both from the Coal-shale of Newsham Colliery.